to 200 lb per acre to allow adjustment for soil type, geographic region and level of production desired for hay and grazing. For tall fescue hay, apply 200 lb per acre on sandy soils and 160 lb per acre on fine-textured soils. On tall fescue pastures for grazing, NCDA&CS recommends 150 lb per acre on sandy soils and 120 on fine-textured soils.

If high yields are not practical or desired, reduce N rates to fit the situation. Apply half the N in mid-February–March and half in mid-August–September. Mid-August is best for western piedmont and mountain pastures. September is best for eastern piedmont and coastal plain pastures.

Table 1 provides guidelines for estimating yield based on general N rates. A given N rate does not guarantee a specific yield due to other limiting factors, such as pH, P, K, rainfall and management.

Warm-Season Annual Grasses

For millet, crabgrass, Sudan grass and Sudan-sorghum hybrids, the NCDA&CS recommends applying approximately 50–70 lb N per acre per year at or before seeding. Apply the remainder in increments of 40–60 lb per acre after each cutting or grazing period.

Table 1. Dry yield (tons/acre) of forage based on nitrogen application (from Green JT 1994, personal communication) *

Forage Crop	Nitrogen Rates (lb/acre) 100	200
Hybrid Bermuda, Gamagrass	2.5–3.0	4.0–5.0
Common Bermuda, Bahia	1.8–2.3	3.0–3.8
Fescue, Orchardgrass, Timothy, Prairiegrass	2.0–2.5	3.5–4.0
Ryegrass (winter annual)	1.5–2.0	3.0–3.5
Small Grain (silage)	1.5–2.0	N/A
Sorghum-Sudan, Millet, Crabgrass	2.0–2.5	3.5–4.5
Sorghum (silage)	3.0–4.0	5.0–7.0
Switchgrass	2.0–4.0	3.0–4.5

* This table is a guide to help select N rates best suited to your soil and management conditions. N rates of 250 lb per acre will increase perennial grass yields on highly productive soils with adequate moisture and intensive management. For more information, see N.C. Agric. Res. Serv. Tech. Bull. 305, *Production and utilization of pastures and forages in North Carolina*.

Warm-Season Perennial Grasses

When establishing common and/or hybrid bermuda or bahia on sandy soils where K leaches, apply only half the K_2O before sprigging or seeding and the remainder at midseason. When plants start to grow, apply 30–40 lb N per acre over the row and another 30–60 lb N per acre when runners appear (6–8 weeks after planting).

To maintain an established bermuda pasture on sandy soils, make split applications of K_2O that coincide with N treatments (3–4 applications per year, depending on the extent of grazing or the number of cuttings). Adequate K is essential to reduce leaf spot, safeguard against winter kill, and optimize yield and quality. Submit soil samples in late summer to find out if K will be needed in the fall.

The N rate for hybrid bermudagrass hay varies with soil type: 220 lb per acre for sandy soils and 175 lb per acre for medium and fine-textured soils. Apply 50–60 lb per acre in April and the remainder in equal increments in June and mid-July or after each cutting.

Grazing: Nitrogen Rate Reduction

During grazing, nutrients are recycled into the pasture. In open-grazing systems, total N rates may be reduced by 25%. Under controlled grazing, a more uniform distribution of animal waste occurs and total N rates may be reduced by 50%.

N.C. Department of Agriculture and Consumer Services

Steve Troxler, Commissioner of Agriculture

NCDA&CS Agronomic Division
Dr. Colleen Hudak-Wise, Director

www.ncagr.com/agronomi/
(919) 733-2655

Mailing Address: 1040 Mail Service Center, Raleigh, NC 27699-1040

Physical Address: 4300 Reedy Creek Rd, Raleigh, NC 27607-6465

October 2006

NOTE 12: Fertilization of Forage & Pasture Crops

Production of quality forage requires a balanced pH and nutrient regime. Soil testing is the best way to determine lime and fertilizer requirements. Submit soil samples from established pastures, hay meadows and silage fields every one to three years to meet yield goals and animal nutritional requirements.

Lime

Your lime recommendation is designed to neutralize soil acidity. When possible, till recommended lime into the soil. On no-till sites or established fields, surface applications are beneficial; however, do not apply more than 1.0 ton per acre at one time.

If recommendations exceed 1.0 ton per acre, apply the excess the following year. Lime rates depend on the current and target soil pH for the specified crop. The target pH for forage crops grown on mineral soils ranges from 6.0 to 6.5.

There are two types of agricultural lime. Calcitic lime is calcium carbonate ($CaCO_3$). Dolomitic lime is a mixture of calcium and magnesium carbonates [$CaMg(CO_3)_2$] and contains a minimum of 120 lb of Mg per ton. Dolomitic lime is an economical source of Mg and reduces the risk of grass tetany in livestock.

Another potential source of lime is lime-stabilized sludge. Since calcitic lime is used with these sludge materials, soil Mg levels should be monitored. When Mg is needed, 25–30 lb per acre are adequate.

For establishment of perennial grasses, NCDA&CS recommends enough lime to raise the pH to 6.5 on mineral soils. This initial application, which is tilled into the soil, fosters a higher pH that allows for a longer production period before additional lime is needed. After establishment, a target pH of 6.0 is appropriate for forage production on mineral soils.

Phosphorus (P), Potassium (K) & Sulfur (S)

Soil testing will accurately predict phosphate (P_2O_5) and potash (K_2O) needs. The following are general

guidelines for fertilizing forage crops at planting and after establishment. Specific nutrient suggestions are given later by crop.

Prior to establishing any forage, refer to current soil recommendations for rates of P_2O_5 and K_2O. If P_2O_5 is needed, till it into the plow layer prior to planting, if practical, since it does not move easily into soil. Incorporation is especially critical for any soils with medium or low P-I values (< 50), especially on perennial crops that are to be productive for several seasons. On soils with high P-I values where less P_2O_5 is recommended, incorporation is not as critical. Commonly available sources of P are triple superphosphate (0-46-0), superphosphate (0-20-0) and diammonium phosphate (18-46-0).

For established crops, apply P_2O_5 before plants begin new growth. Do not apply it prior to rainfall events if not incorporating it because runoff is likely. Also, do not apply P_2O_5 if it is not recommended. Doing so may lower economic returns and lead to excessive accumulation in the soil. Special considerations related to P use may apply in river basins designated as Nutrient Sensitive Waters.

When K_2O is recommended for new plantings, you can apply the full rate and incorporate it with P_2O_5 on medium and fine-textured soils. K may leach on sands that have low cation exchange capacities (CEC values) and low water-holding capacities, especially in seasons with excessive rainfall. Split applications may be beneficial to increase use efficiency. On such sites, apply half the recommended rate at planting. Apply the rest at midseason of new growth or split it into two equal applications during the growing season.

For crops established on medium or fine-textured soils, you can apply all K_2O just before new growth begins. On sands, apply half at the beginning of the growing season and the remainder at midseason. Alternatively, you can apply K_2O in equal applications after each cutting or at each nitrogen (N) application, depending on the crop. Commonly available sources of K are muriate of potash (0-0-60), potassium sulfate (0-0-50) and potassium magnesium sulfate (0-0-22).

Sulfur is usually present in adequate amounts in medium- and fine-textured soils. Like K, it is subject to leaching on sands, especially in seasons with excessive rainfall. The soil test report gives a sulfur recommendation whenever S-I $\leq$ 25. On crops receiving N applications, apply any recommended S when N is first applied. Since S leaches readily, it may be adequate at the time of the report but be limiting later during the season. Plant tissue analysis can be used in-season to test for sufficiency.

Animal Waste as a Nutrient Source

Soil application of poultry and animal wastes provides nutrients such as N, P_2O_5, K_2O and S. Use of livestock wastes reduces the need for commercial fertilizers and disposal of waste products. Waste products should be analyzed for nutrient content prior to application. The NCDA&CS Agronomic Division provides a waste analysis service that helps determine suitable applications rates.

Always use a current soil test report as a guide in animal and poultry waste management plans. On farms governed by water quality or waste regulations, base N and P_2O_5 rates on nutrient management guidelines. Off-site movement of both N and P can negatively affect water quality. Also, excess N from manure causes overabundant vegetative growth, which promotes plant disease and causes nitrate poisoning in livestock.

Animal wastes may contain high levels of micronutrients (zinc and copper) so soil levels should be monitored.

Alfalfa

Alfalfa is very sensitive to acid soils. It requires a soil pH of at least 6.5 for optimum growth. Adequate Ca levels are also essential for high yields. Lime not only neutralizes soil acidity but also provides essential Ca and Mg.

Molybdenum (Mo), a micronutrient essential for symbiotic N fixation (nodulation), becomes more available as soil pH increases. However, some soils are inherently low in Mo. Under such conditions, apply Mo to the soil at the rate of 0.25–0.5 lb per acre.

When seeding legume forage crops, use an inoculant containing Mo. On established fields, a foliar application of 3.0 ounces of Mo in 25 gallons of water per acre will correct a deficiency. Apply foliar Mo in spring before new shoots are 2–3 inches high.

Alfalfa also requires high levels of boron (B). Since most soils are low in B, broadcast 3.0 lb per acre for establishment and 2.0 lb per acre per year for maintenance. There is no reliable soil test for Mo and B, but plant tissue analysis will identify deficiencies. If problems develop during the growing season, submit soil and plant samples for analysis.

Alfalfa requires high soil P and K (P-I, K-I > 50) to sustain yields. The K removed from the soil by the crop must be replenished with fertilizers. Where K is subject to leaching, apply half the recommended K_2O in March. Apply the remainder in June after the second cutting. When leaching is not a concern, apply all the K_2O in fall, in early spring or in split applications.

Clover-Grass Mixtures

Well-balanced clover-grass mixtures that contain tall fescue, orchardgrass, prairiegrass or timothy do not need N. If applied, it promotes competition between clover and grasses and often leads to a pure grass stand. However, if the clover stand is less than 25% and re-establishment of clover is not desired, apply fertilizers as recommended for pure grass stands. Refer to the section **Cool-Season Perennial Grasses** for fertilizer and lime recommendations.

White Clover & Bluegrass

Most clover-bluegrass pastures are grown in the mountains at elevations above 2000 ft. The most prevalent fertility problem is low P. When P_2O_5 and K_2O are recommended, apply the full amounts either in early spring or fall. Although response to P often exceeds response to lime, most mountain pastures are quite acid and would benefit from liming.

A balanced clover-grass stand does not need N. In such a stand, the N supplied by the clover does not promote grass growth to the extent that it competes with clover. However, to shift peak production to an earlier period, apply 50–60 lb N per acre per year in either early August for fall growth or March for early spring growth. Be aware that while early N application enhances grass production, it may have a negative effect on clover unless the grass is properly grazed to a height of less than 8 inches.

Cool-Season Perennial Grasses

The N rates for cool-season grasses—such as fescue, bluegrass, orchardgrass and timothy—range from 100